carrier gas, wherein the obtained carbon fiber comprises about 100 ppm or less of a metal element selected form the group consisting of Fe, Ni, Co, Cu, Mo, Ti, V and Pd.

14. (Amended) A carbon fiber obtained by a method for producing carbon fiber, said method comprising a step of carrying out a thermal decomposition reaction of a carbon source and a transition metal catalyst, serving as main raw materials, and step of heat treating the thermal decomposition, wherein said step of heat treating comprises a high-temperature heat treatment method for carbon fiber which has been produced through thermal decomposition reaction of a carbon source and a transition metal catalyst, serving as main raw materials, which heat treatment method comprises vaporizing an impurity through a high-temperature section of a heat treatment furnace while being accompanied by a carrier gas, wherein the obtained carbon fiber comprises about 100 ppm or less a metal element selected from the group consisting of Fe, Ni, Co, Cu, Mo, Ti, V and Pd.

Please add the following new claims:

15. (New) The carbon fiber as claimed in claim 13 or 14, wherein the high temperature section of a heat treatment operates at approximately 2,000-3,300 °C.

16. (New) The carbon fiber as claimed in claim 13 or 14, wherein the carbon fiber has a diameter of about 0.005 to about 5 μm and a length of about 1 to about 1000 μm.

REMARKS

The Office Action of January 29, 2003 has been received and its contents carefully considered.

The Examiner has not acknowledged applicants' claim for domestic priority. Applicants request the Examiner to acknowledge applicants' claim for domestic priority.

The Examiner has made of record the telephone restriction requirement and applicants' election of the invention of Group III Claims 11-14. The Examiner states that applicants must affirm this rejection when responding to the Office Action. Applicants hereby affirm this election.

Claims 11-14 have been rejected under 35 U.S.C. § 102(e) as anticipated by, or in the alternative, under 35 U.S.C. § 103(a) as obvious over U.S. Patent 6,045,769 to Kambe et al.

Applicants submits that Kambe et al do not disclose or render obviously presently claimed invention and, accordingly, request withdrawal of this rejection.

Applicants have cancelled claims 11 and 12, have amended claims 13 and 14 and have added new claims 15 and 16.

As set forth in amended claim 13, which has been placed in independent form, the present invention is directed to a carbon fiber obtained by a high temperature heat treatment method for carbon fiber which has been produced through thermal decomposition reaction of a carbon source and a transition metal catalyst, serving as main raw materials, which method comprises vaporizing an impurity contained in the carbon fiber, and discharging the impurity through a high-temperature section of a heat treatment furnace while being accompanied by a carrier gas, wherein the obtained carbon fiber comprises about 100 ppm or less of a metal element selected form the group consisting of Fe, Ni, Co, Cu, Mo, Ti, V and Pd.

As set forth in claim 14, which has also been placed in independent form, the present invention is directed to a carbon fiber obtained by a method for producing carbon fiber, said method comprising a step of carrying out a thermal decomposition reaction of a carbon source

and a transition metal catalyst, serving as main raw materials, and step of a heat treating the thermal decomposition, wherein said step of heat treating comprises a high-temperature heat treatment method for carbon fiber which has been produced through thermal decomposition reaction of a carbon source and a transition metal catalyst, serving as main raw materials, which heat treatment method comprises vaporizing an impurity through a high-temperature section of a heat treatment furnace while being accompanied by a carrier gas, wherein the obtained carbon fiber comprises about 100 ppm or less a metal element selected from the group consisting of Fe, Ni, Co, Cu, Mo, Ti, V and Pd.

In addition, applicants have added a new claim 15, which depends from claim 13 or 14, and which states that the high-temperature section of the heat treatment operates at a approximately 2,000-3,300 °C. Support for new claim 15 can be found, for example, at page 7 lines 8-11 of the specification.

In addition, applicants have added a new claim 16. Support for this new claim can be found at page 1, lines 24-27 of the specification.

The Kambe et al patent discloses a process for producing elemental carbon, which can be in the form of carbon fiber, by pyrolysis of hydrocarbons and other carbon containing molecules in the presence of catalysts which are provided for the use of lower temperatures to generate the elemental carbon. Suitable catalysts articles include iron, iron carbide and iron sulfide particles.

Kambe et al disclose at column 11, lines 44-49, that the reaction chamber is heated generally to a temperature up from about 650 to about 1,300 °C. Kambe et al state that the

temperature should be selected to be high enough for the catalytic production of elemental carbon, but low enough such that significant amounts of thermal carbon are not produced.

Kambe et al do not disclose subjecting the carbon fiber to a heat treating step to remove an impurity contained in the carbon fiber, and do not disclose the specific heat treating of the present invention, which comprises vaporizing an impurity contained in the carbon fiber and discharging the impurity through a high temperature section of a heat treatment furnace while being accompanied by a carrier gas.

Kambe et disclose removing catalyst particles "associated" with the carbon fibers by treatment with aqueous hydrochloric acid or other suitable composition that does not disrupt the carbon component, but Kambe et al do not disclose a heat treatment to remove the catalyst particles or an impurity contained in the carbon fiber. Thus, the Kambe et al method for removal of the catalyst particles is different from the method of removing an impurity set forth in the present claims.

The Kambe et al method for removing catalyst particles associated with the fiber by treating with hydrochloric acid or other suitable compositions is useful for resolving catalyst particles such as iron, iron carbide and iron sulfide particles by HCL or a suitable composition. For example, the reaction that would take place in Kambe et al by the use of hydrochloric acid is shown below:

$$Fe + HCl \rightarrow FeCl, FeCl_2 + H_2$$

$$Fe_2S_3 + 4HCl \rightarrow 2FeCl_2 + 2H_2S + S$$

Applicants point out that FeCl and $FeCl_2$ will be resolved by water. Fe and Fe_2S_3 are not water soluble.

On the other hand, in the present invention, an impurity contained in carbon fiber, such as a transition metal, and not a metal compound and not a catalyst particle, is vaporized and removed at high temperature, such as approximately 2000 - 3,300 °C, accompanied by a carrier gas fed in the furnace.

The temperature of the atmosphere in the furnace is low, such as about 2000 °C or lower at the end of the furnace, and then the vaporized impurity, for example, the vaporized transition metal, is condensed and solidified at the end of the furnace. The resultant transition metal easily reacts with a carbon (such as with the furnace, a carbon fiber, or a heating body) to form a carbide of transition metal.

The present invention provide a method for preventing damage to a furnace and preventing the carbon fiber from being subjected to impurities. In the present invention, the carbon fiber is not susceptible to impurities, and as set forth in claims 13 and 14, comprises about 100 ppm or less of a metal element.

Kambe et al do not disclose the amount of catalyst particles that remains after the catalyst particles are removed by treatment with aqueous hydrochloric acid or other suitable composition. The Examiner takes the position that since Kambe et al do not indicate how much catalyst is removed, it is expected that this removal would be complete.

Applicants submit that there is absolutely no basis for the Examiner to assert that the removal would complete. In general, purification or removal methods do not result in complete removal. Accordingly, applicants submit that Kambe et al do not anticipate the present claims.

Further, applicants submit that there is no basis for the Examiner to assume that the Kambe et al removal method can be performed for a long enough time for complete removal of the catalyst particles. Applicants submit that removal methods of impurities are generally never complete. Applicants submit that there is absolutely no basis for the Examiner to assume that removal by aqueous hydrochloric acid or other suitable composition would result in a complete removal and result in a carbon fiber containing 100 ppm or less of the recited metals.

In view of the above, applicants submit that the cited prior art does not disclose or rendered obviously presently claimed invention and, accordingly, request withdrawal of this rejection.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

Respectfully submitted,

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